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# California's Forests: Where Have All the Big Trees Gone?

They've gone to logging and housing—but especially to climate change, says a new study.

By **Warren Cornwall**, [National Geographic](#)

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California has lost half its big trees since the 1930s, according to [a study to be published Tuesday](#) in the *Proceedings of the National Academy of Sciences*—and climate change seems to be a major factor.

The number of trees larger than two feet in diameter has declined by 50 percent on more than 46,000 square miles of California forests, the new study finds. No area was immune, from the foggy northern coast to the Sierra Nevada Mountains to the

San Gabriels above Los Angeles. In the Sierra high country, the number of big trees has fallen by more than 55 percent; in parts of southern California the decline was nearly 75 percent.

Many factors contributed to the decline, said Patrick McIntyre, an ecologist at the state Department of Fish and Wildlife who was the lead author of the study. Loggers targeted big trees. Housing development pushed into the woods. Zealous fire suppression has left California forests crowded with small trees that compete with big trees for resources.

But in comparing a census of California forests done in the 1920s and 1930s with another survey between 2001 and 2010, McIntyre and his colleagues documented a widespread demise of big trees that was evident even in wildlands protected from logging or development.

The loss of big trees was greatest in areas where trees had suffered the greatest water deficit. The researchers estimated water stress with a computer model that calculated how much water trees were getting versus how much they needed, taking into account such things as precipitation, air temperature, soil moisture, and the timing of snowmelt.

The current drought, now entering its fourth year, does not figure in the new study—even though it's taking a toll on California's trees—because the most recent forest census ended before the drought began. (Read "When the Snows Fail.")

Since the 1930s, McIntyre said, the biggest factors driving up water stress in the state have been rising temperatures, which cause trees to lose more water to the air, and earlier melting of snowpacks, which reduces the water supply available to trees during the dry season.

### **Suffering Pines**

The findings mesh with previous work done on a smaller scale. In 2009, scientists reported that the number of big trees in Yosemite National Park had fallen by nearly a quarter since the 1930s. Some of the most severe declines in Yosemite were among pine trees, including ponderosa, sugar, and Jeffrey pines.

The new study shows that a similar decline is happening among pines throughout the state. But the data are too sparse to say whether the state's trademark giants—sequoias and redwoods—are also losing some of their stature, McIntyre said.

Large trees in general appear to be more vulnerable to a water shortfall, he said. Though it's not clear why, one reason may be that in large, tall trees the internal hydraulic system that pumps water from roots to leaves is more susceptible to failing when water is short. Another factor could be that many of those trees sprouted centuries ago, when California's climate was colder, said Jim Lutz, a Utah State University forest ecologist and lead author of the Yosemite study.

“Those individuals were very well adapted for the climate

when they were growing rapidly. And that's different from the climate now," Lutz said.

While the number of big trees has declined in California, the number of trees smaller than a foot across has surged across the state, and trees between one and two feet in diameter have fared well in a number of areas. Aggressive wildfire control is thought to have abetted the trend, by letting forests fill with small trees that might have succumbed to more frequent fires.

But in another sign that climate is changing California's forests, McIntyre and his colleagues found that oaks are replacing pine trees in large swaths of the state. Oaks are an increasing presence in the Sierras and along the north coast, while declining slightly in southern California. Pines meanwhile have declined everywhere.

That's what one would expect in a warming climate, McIntyre said: Pollen records going back 150,000 years show that oaks have thrived in hotter, drier eras, while pines were more plentiful during cooler ones.

### **More Heat, Fewer Giants**

The future looks challenging for California's big trees. By 2100, the state's average temperature could rise by as much as 9°F compared to the late 20th century, raising the overall water stress for plants by 30 percent, said McIntyre.

Princeton forest ecologist William Anderegg, who was not

involved in the new study, lamented what he called the likely “shrubbification” of western forests, as drier conditions encourage smaller, more tightly packed trees. “The loss of these majestic largest trees is a pretty emotionally powerful thing to think about,” said Anderegg. “These are often the trees that have been around for thousands of years. It’s kind of a less magical future having lost those trees.”

Beyond their romantic grandeur, big trees play an outsized ecological role. They produce more seeds, resist wildfire damage, and store more carbon than their smaller brethren; rare animals such as spotted owls and flying squirrels live in their cavities.

The loss of such trees thus has important implications for the health of the Golden State’s forests, said University of Washington forest ecologist Jerry Franklin. “It’s not a happy prospect from the standpoint of a lot of different things,” he said.

*Editor’s Note: An earlier version of this story incorrectly identified the trees in the lead photo as Ponderosa pines. This is actually a collection of tall trees, including sequoias to sugar pines.*



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